Syllabus MSNE 437+537 revised 10Apr2016 by P.Loos

CRYSTALLOGRAPHY AND DIFFRACTION LAB - Selected lab experiments in materials science. This course is designed to complement the lectures in MSNE/PHYS 435/535, which must be taken concurrently or previously. The lab experiments concern the structure and constitution of materials as revealed by x-ray scattering, including diffraction and refraction. **This lab is required for the BS MSNE degree** but optional for other degrees. Undergrads planning to stay at Rice for grad school should probably take 537.

Instructors: Dr. Peter Loos **office**: MEB 215 ploos@rice.edu **Office hours:** after class and by appointment.
Dr. Pei Dong **office**: MEB 125 pei.dong@rice.edu **Office hours**: after class and by appointment.
X-ray Scattering Lab Manager: Dr. Jianhua Li **office:** SS B08
Teaching Assistants: Reid Carazzone Reid.Carazzone@rice.edu and Jiangtan Yuan JIANGTAN.YUAN@rice.edu
Location: Meet in SS B06 for experimental work and for organizational meeting in RL B08.
Schedule: Sections meet Mon. 11:00, Tues. 2:30, Wed. 2:00 for about 2 hours each
Text: Cullity, ***Elements of X-ray Diffraction***, either 3rd or 2nd edition, plus additional assigned reading.

Grading: Based on attendance, participation, safety, ability to operate the equipment, and neatness in lab, as well as accuracy of results turned in. Students whose efforts during the semester are unsatisfactory will have the opportunity to take a final exam for extra credit.

All students will complete labs #1 through #6. **537 students** will also complete one additional lab exercise.

Absence Policy: Students are expected to attend every class meeting. Contact Instructor and/or TA as soon as it becomes apparent that an absence cannot be avoided. Any absence from the hands-on data collection must be made up.

Safety: There will be a reading assignment and quiz about x-ray safety. The quiz can be taken as many times as needed to get all the answers correct.

Areas of Instruction: There will be eight lab exercises, accompanied by reading in the text and in other references. These exercises might be changed based on interests expressed by the students and availability of the instruments.

#1 x-ray safety
#2 Film thickness, density & roughness by x-ray reflectometry (XRR).
#3 Emission spectrum of the Cu x-ray tube, x-ray absorption, filtering the spectrum.
#4 Identification of unknown powder samples using Jade and the ICDD Powder Diffraction File (PDF).
#5 Determination of volume fractions of multiple phases in a mixture using reference intensity ratios.
#6 Film thickness by XRD using Scherrer's formula and a Williamson-Hall plot
#7 Based on students' research interests, such as identifying unknown samples and indexing their diffractometer patterns using Jade and PDF, or pole figures, or precise lattice parameter measurement and alloy stoichiometry using Vegard's Law.

Instrumentation: Dmax West is used in experiments #4, 5, 6 and SmartLab is used in experiments #2 & 3. These Rigaku machines are all located in SS B06. For info see http://sea.rice.edu/instruments/rigaku-dmax-east-ultima-ii-powder-xrd-6s and http://sea.rice.edu/instruments/rigaku-dmax-west-ultima-ii-powder-xrd-1s and http://sea.rice.edu/instruments/rigaku-smartlab-xrd.

Lab Results: Students work together in small groups when operating the equipment and collecting & analyzing data with Jade or Rigaku GlobalFit software; however, students must independently use their own spreadsheets to analyze other experimental data. Results are turned in per the Rice Honor Code and due two weeks after data are collected. Points may be deducted for late results.

Computation: We will use Jade software and the ICDD Powder Diffraction File (PDF) database. Four copies of this software are running on Windows machines in SS B06. We will also use Rigaku GlobalFit software which is installed on two computers in SS B06. Spreadsheet software will also be used extensively.

Goals for this course: **To address ABET Student Outcomes and Program Criteria, students will have**
(a) an ability to apply knowledge of mathematics, science, and engineering
(e) an ability to identify, formulate, and solve engineering problems
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
and the course will
- prepare graduates to apply advanced science … and engineering principles to materials systems …
- prepare graduates to utilize experimental, statistical, & computational methods …

More specifically:
(1) Students will be able to determine the crystal structure of most metals and ceramics experimentally.
(2) Students will be able to use XRD data to determine composition and size of crystallites in a crystalline solid.
(3) Students will be able to use reflectometry to characterize thin films.
(4) Students will be able to operate the Rigaku Dmax machines unsupervised.
(5) Students will be able to use most of the features in Jade.

NOTICE: Any student with a disability requiring accommodations in this class is encouraged to contact Instructors after class or during office hours. Additionally, students should contact the Disabled Student Services in Allen Center.